

A STUDY OF THE ASTRAGALUS. By R. B. SEYMOUR SEWELL,  
B.A., *Christ's College, Cambridge, Fellow of the Anthropological  
Institute.*

PART IV.

THE CAPUT.

THE *caput*, or head of the astragalus, comprises all the smooth articular portion of the bone lying anterior to the neck.

In shape this surface is, as has been pointed out by Barclay Smith (2), of an ellipsoidal character, and in consequence the astragalo-calcaneo-navicular joint must be placed among the condylarthroses: in the Egyptian astragalus the long axis of the head, around which movement takes place,

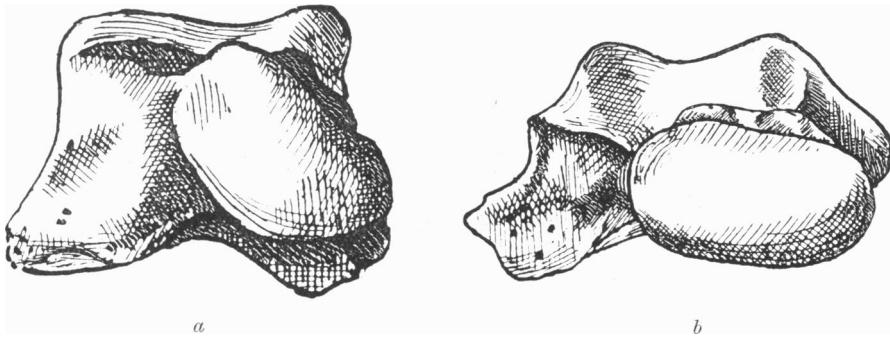


FIG. 29. —Anterior end of astragalus—showing the inclination of the long axis of the caput to the horizontal plane of the trochlear surface. *a*, Human; *b*, Orang utan.

passes from above and to the outer side downwards and inwards at an angle of approximately  $45^{\circ}$  with the transverse plane of the trochlear surface; but when we come to the consideration of this axis in the astragali of the anthropoid apes we meet with a considerable difference, for in these animals the long axis of the joint is much more nearly parallel with the trochlear plane.

Aeby (1) has pointed out that the value of this angle increases as we pass from the anthropoid apes to man, and I have since been able to confirm this.

I have also found that we meet with differences in respect of this angle in different human races. Thus in the Egyptian the angle has on the average a value of  $43.5^\circ$ , whereas the average value obtained from thirty-five specimens from Borneo was only  $41^\circ$ .

These varying values can be arranged in order of magnitude as follows:—

Orang (young) . . . . .	$8^\circ$
Human (fœtus) . . . . .	$10^\circ$
Orang (adult) . . . . .	$12^\circ$
Gorilla . . . . .	$12^\circ$
Human adult (Borneo) . . . . .	$41^\circ$
Human adult (Egyptian) . . . . .	$43.5^\circ$

It is evident, therefore, that during the process of eversion of the foot the line of articulation of the caput tali has been rotated in the manner shown.

We also meet with very considerable variation in the value of this angle in individual specimens. Thus in the Egyptian series of bones in No. 642 the angle measured  $62^\circ$ , whereas in No. 502 it was only  $25^\circ$ ; and in the collection of bones from Borneo we find almost as great variations—No. 2 presenting an angle of  $59^\circ$  while in No. 33 the value was only  $26^\circ$ .

The surface of the caput is subdivided into several articular facets, although the facility with which the various surfaces can be recognised, varies to a very considerable extent in different specimens; thus in some cases the facets are separated from one another by low intervening ridges, whereas in others all trace of separation is lost and the whole caput presents a uniformly smooth surface.

Turning now to the consideration of the individual facets, the first which we will study is the *facies articularis navicularis*.

This facet occupies the most anterior portion of the caput: in outline it is roughly oval, its long axis corresponding fairly closely with the direction of the long axis of the caput.

The articular surface presents a convex curvature in both the long and the short axes of the facet.

Above and to the outer side the facet is usually sharply marked off from the roughened surface of the collum tali, but in those cases in which a well-marked processus trochlearis is present on the upper surface of the neck the articular surface may be continued on to its anterior aspect; or, again, in rare cases we find that the facet is prolonged backwards along the smooth external margin of the collum so as almost to meet the

trochlear surface on the corpus—a condition of which I have only succeeded in obtaining two examples, Nos. 122 and 754.

Internally and above, the edge of the articular surface is, as a rule, somewhat bevelled off, thus providing a smooth surface, over which the ligamentum talo-navicularis profundum glides.

We may occasionally find a specimen in which the articular surface is prolonged backwards on the medial aspect of the collum tali; and in one case, No. 767, it reached back as far as the facies malleolaris medialis, thus completely obliterating the medial portion of the neck of the bone.

Below and to the inner side the facet becomes continuous with the other articular surfaces of the caput, the lines of separation being as a rule merely indicated by low articular ridges, which are not usually very distinct, but in certain specimens are very well marked.

At the inner border of this facet we meet with two distinct conditions; in the majority of cases—*i.e.* in about 60 per cent.—the margin of the articular surface becomes continuous with the margin of the facet for the tendon of the tibialis posticus muscle, forming a uniform curve, whereas in the other 40 per cent. of the specimens examined this margin is interrupted by a well-marked notch which runs downwards and forwards for some short distance between the two facets.

The inferior or ventral portion of the caput is occupied by two articular surfaces—the facies articularis calcanea anterior externally, and the facet for the ligamentum calcaneo-naviculare inferius internally.

*Facies Articularis Calcanea Anterior.*—This facet is usually somewhat irregularly oval in outline, but it varies through a considerable range both in its shape and size. The surface anteriorly and above is separated from the facies articularis navicularis by, as a general rule, only an indistinct low ridge, but in certain cases we find that these two surfaces are separated off very distinctly from one another, the angle between them being nearly a right angle. This seems to be particularly the case in those specimens in which the facies articulares calcaneæ anterior et media are fused together to form a single articular surface.

Externally and somewhat posteriorly the facet is sharply marked off from the roughened surface of the sinus tarsi by a prominent and frequently somewhat overhanging border.

At its antero-internal margin it is only separated from the facet for the ligamentum calcaneo-naviculare inferius by an indistinct ridge, while posteriorly it is only indistinctly marked off from the facies articularis calcanea media of the collum tali—the two surfaces meeting at a wide angle.

Occasionally, however, the angle at which these two surfaces meet is

much smaller, and in such cases the two facets are very distinctly marked off from one another.

As I have already pointed out, we occasionally come across a specimen in which the rough internal or external, or more rarely both, aspects of the collum tali are prolonged between these two articular surfaces, so as to separate them either partially or entirely by a narrow band of rough bone; this condition I have found to be present in about 2 per cent. of the specimens which I have examined.

As Barclay Smith has shown (2), there is present in the astragalo-calcaneo-navicular joint a small interarticular ligament, which runs from the head of the astragalus to become attached to the ligamentum calcaneo-naviculare inferius, and when it is well developed this notch or groove between the anterior and middle calcaneal facets serves to give attachment to the fibrous band.

One not infrequently comes across a specimen which presents the extreme opposite condition; in such cases all trace of any distinction between these two facets is completely lost, and one then gets a single elongated articular surface, reaching from the facies articularis navicularis in front to the sulcus interarticularis behind.

In rare instances we find that the facies articularis calcanea anterior is absent altogether. Such a condition existed in six cases—Nos. 193, 201, 572, 877, 910, 931. In these bones the rough external aspect of the collum extended forwards and inwards as far as the facet for the ligamentum calcaneo-naviculare inferius, which was usually in these cases somewhat increased in size (*vide* fig. 29).

With regard to the articular surface, it is found that in the coronal plane, *i.e.* from side to side, it usually presents a slight convexity, but occasionally we come across a specimen which possesses a concavo-convex curvature, the outer part of the facet being convex while the inner portion is concave. In the sagittal plane the curvature is found to vary considerably—more commonly the surface is either flat or slightly concave, and in a few cases a well-marked degree of concavity is present; in other specimens, however, the surface presents a slight though well-marked convex curvature.

*Faces for the Tendon of the Tibialis Posticus Muscle.*—This articular surface was first described by Fawcett (4). Previous to this, it had always been regarded as part of the facet for the ligamentum calcaneo-naviculare inferius, but, as this observer has pointed out, over the inner side of the caput of the astragalus this ligament is “so thin that it could scarcely cause so well-marked a facet,” and hence we must look for some other cause. This, according to Fawcett, is to be found in the tendon of the

tibialis posticus muscle, "which runs downwards and forwards by the side of the head of the astragalus," being separated from it merely by the thin lateral margin of the ligament.

The facet is roughly quadrilateral in shape and presents two curvatures, being slightly concave from above downwards and convex from side to side.

Anteriorly the articular surface is bounded by the *facies articularis navicularis*, and posteriorly by the *facies articularis calcanea media*.

Above and to the inner side the facet is sharply marked off from the

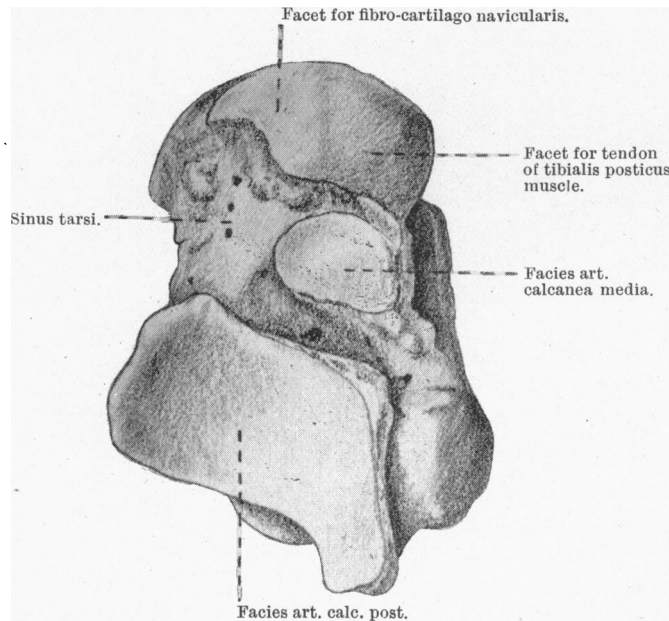


FIG. 30.—Norma basilaris—showing absence of the *facies articularis calcanea anterior*. No. 201.

rough surface of the *collum tali*, and we not infrequently come across a specimen in which this rough surface is prolonged downwards as a wide notch between this facet and the *facies articularis navicularis*.

Externally and below the articular surface is bounded by the facet for the *ligamentum calcaneo-naviculare inferius*, being usually separated from it by a faint ridge; though in a large number of specimens no trace of any separation can be seen, the two facets being indistinguishably blended together to form a single articular surface.

As Fawcett has pointed out, the articular cartilage covering these two facets is very soft and in macerated specimens is usually wanting, thus

leaving rough bare bone; the layer of compact bone which forms the surface is also of a rather delicate nature, and in a large number of specimens has been broken away.

We occasionally meet with specimens which present extra accessory facets; these articular surfaces are of two kinds: (a) for articulation with the cuboid bone, and (b) for articulation with a little ossicle known as the *calcaneus secundarius*.

*Facet for the Cuboid Bone.*—The occurrence of this facet has been recorded by T. Wardrop Griffiths (5) and by Bland Sutton (3). The facet

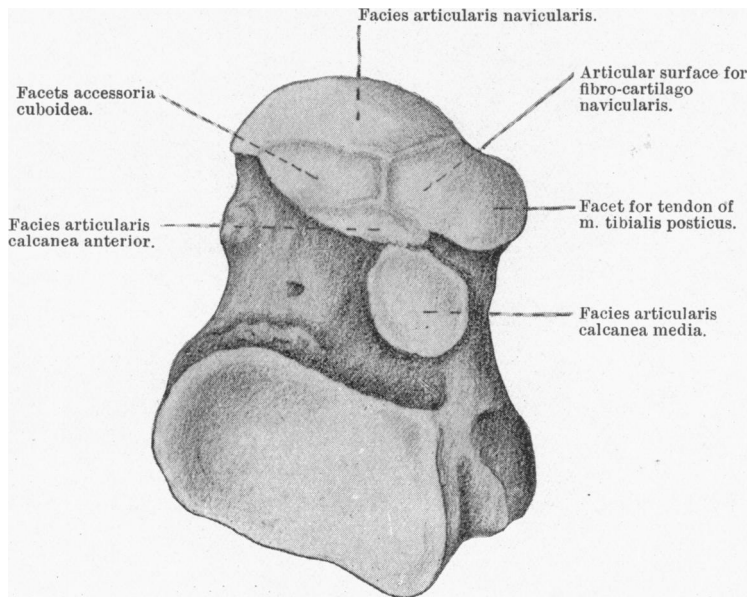


FIG. 31.—Norma basilaris—showing accessory facet for the cuboid.

is of very rare occurrence, and I have only succeeded in finding it in two specimens.

In shape the articular surface is roughly quadrilateral (fig. 30), and is only marked off to a very slight extent from the rest of the articular surface of the *caput*.

The facet is situated in front and slightly to the outer side of the *facies articularis calcanea anterior*, which is somewhat diminished in size: to the inner side is the facet for the *ligamentum calcaneo-naviculare inferius*, and between these two articular surfaces is a low rounded ridge, while anteriorly the area is bounded by the *facies articularis navicularis*.

In one specimen, No. 493, the *facies articularis calcanea anterior* was reduced very considerably in size and formed merely a narrow articular surface in front of the *facies articularis calcanea media* (*vide* fig. 31). In front of this narrow facet was a triangular area with slightly raised edges and a smooth concave surface, which was perforated by several small foramina.

The base of the triangle was towards the outer side of the *caput*, and here the facet blended with the rough external surface of the *collum tali*.

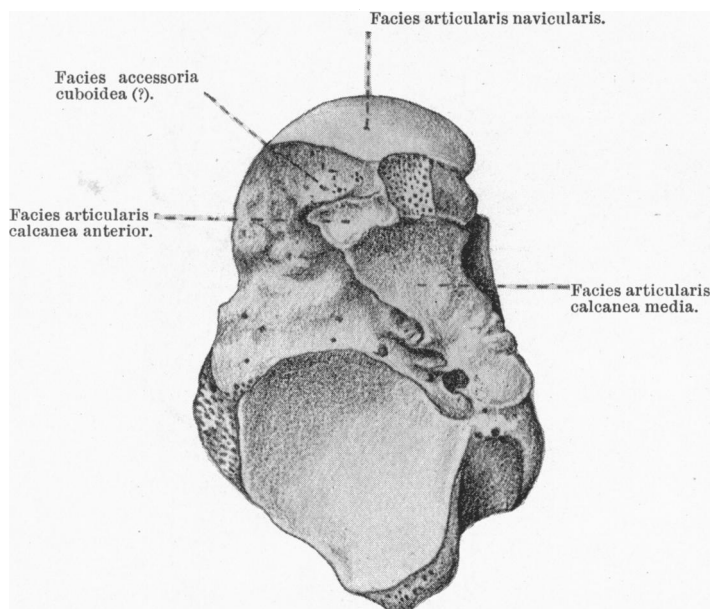


FIG. 32.—Norma basilaris—showing accessory facet probably for the cuboid. No. 493.

This concave area was apparently for articulation with some other part of the tarsal skeleton; and as the position it occupies is identical with that of the facet for the cuboid, I am inclined to think that it must have been for this latter bone, though the articular surface differed in several particulars from the conditions usually present in the facet.

*Facet for the Calcaneus Secundarius Ossicle.*—As Professor Pfitzner (7) has pointed out, this ossicle is situated at the anterior end of the *os calcis* and somewhat to the outer side, and was present in 2 per cent. of the feet examined.

In a certain number of cases this ossicle comes in contact with the *caput tali* and gives rise to an articular facet. Such a facet I found to be present

in fourteen specimens—Nos. 20, 23, 436, 450, 501, 536, 612, 614, 660, 741, 809, 810, 816, 969.

In all the cases the facet was roughly rhomboidal or oval in shape and was situated on the under or ventral surface of the caput (*vide* fig. 32). In front, the articular surface abutted on the *facies articularis navicularis*; to the inner side was the facet for the *ligamentum calcaneo-naviculare inferius*, while to the outer side and behind the area was limited by the *facies articulares calcaneæ anterior et media* respectively.

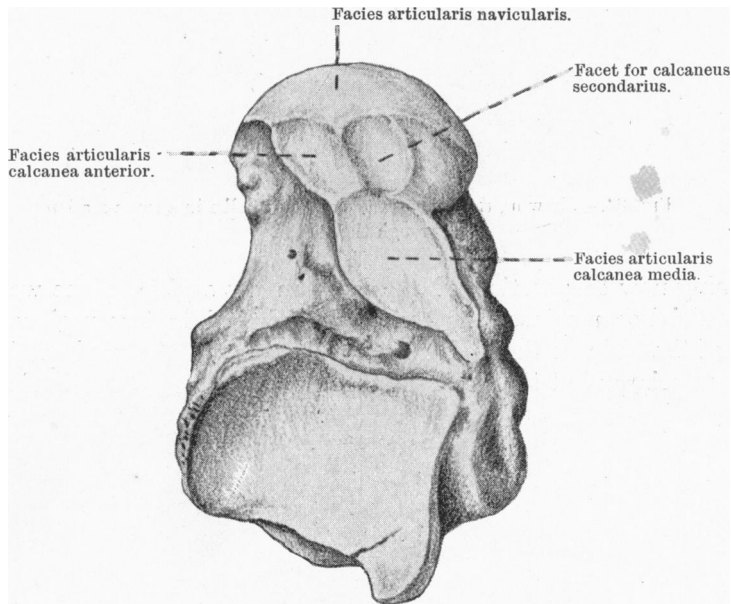


FIG. 33.—Norma basilaris—showing facet for the calcaneus secundarius ossicle. No. 450.

*Architecture of the Bone.*—One cannot leave the subject of the astragalus without saying a few words with regard to the arrangement of the lamellæ in the cancellous tissue of the bone.

In the astragalus, as in all other bones, the lamellæ are arranged in definite planes corresponding to the lines of force which act upon the various surfaces.

Taking first of all the arrangement in the corpus, we see that in a transverse vertical section two sets of lamellæ can be distinguished—(a) a vertical and (b) a horizontal set, crossing one another at right angles.

The vertical set run in the sagittal plane from the trochlear surface above downwards to the *facies articularis calcanea posterior*, and thus serve



to transmit the weight of the body from the tibia above to the os calcis below.

The horizontal set of lamellæ runs from side to side of the bone, thus strengthening the two malleolar facets and at the same time supporting the vertical set.

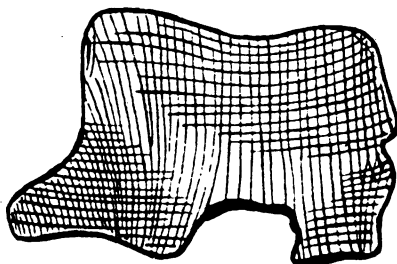


FIG. 34.—Showing the arrangement of the lamellæ in a trans-section through the corpus.

Turning now to a section of the bone in the sagittal plane we see that the superficial compact bone is specially thickened in two regions—at the portion of the bone on the under surface that forms the roof of the sulcus interarticularis, and at the neck on the upper surface. The horizontal set

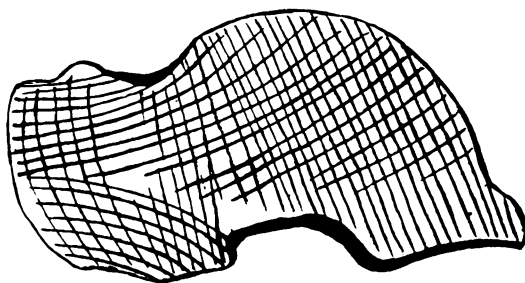


FIG. 35.—Showing the arrangement of the lamellæ in a sagittal section through the astragalus.

of lamellæ which we observed in the previous section, we now see to be running from the trochlear surface forwards and downwards through the neck to end mainly in the upper part of the facies articularis navicularis; in the neck region this set is reinforced by a series of strong lamellæ, which arises from the specially thickened layer of compact bone which we have already mentioned.

In the neck and head region we also get another set of lamellæ, which

in a sagittal section are seen cut across: these start from the facies articularis calcanea media on the under-surface of the neck, and curve upwards and forwards and finally end in the lower portion of the facies articularis navicularis.

Just above the sulcus interarticularis the cancellous tissue is of a comparatively open character.

As has been pointed out by Sir George Humphry (6), the consideration of the arrangement of lamellæ in the astragalus leads one to conclude that the weight of the body is transmitted either downwards and backwards on to the os calcis, or forwards to the navicular, and that very little of the weight falls on that part of the head which is supported only by the ligamentum calcaneo-naviculare inferius and the tendon of the tibialis posticus.

In conclusion, I wish to record my sincerest thanks to Professor Macalister, who has given me considerable assistance during this work, and also to Dr W. L. H. Duckworth and Mr Oldfield Thomas, who have kindly permitted me to examine the anthropoid astragali in the various collections under their charge.

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